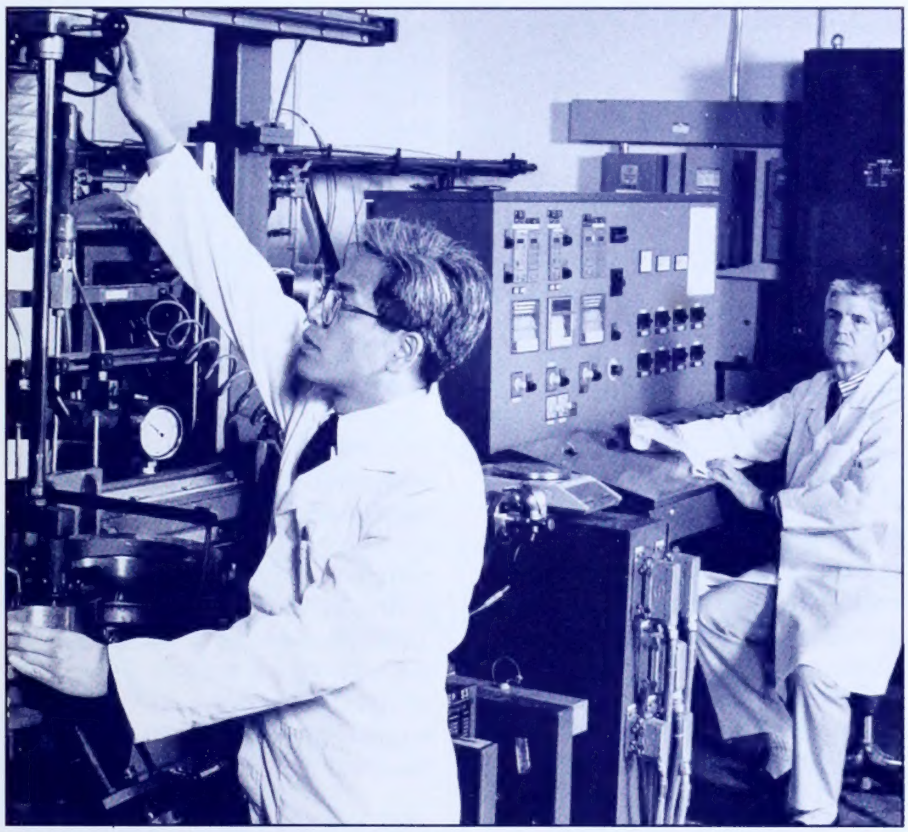
Research Report

Alberta Agricultural Research Institute Summer 1993



Drs. Evans and Nguyen demonstrate Norac's supercritical extraction unit.

Silk purses from sows' ears

Adding value to Alberta's meat industry

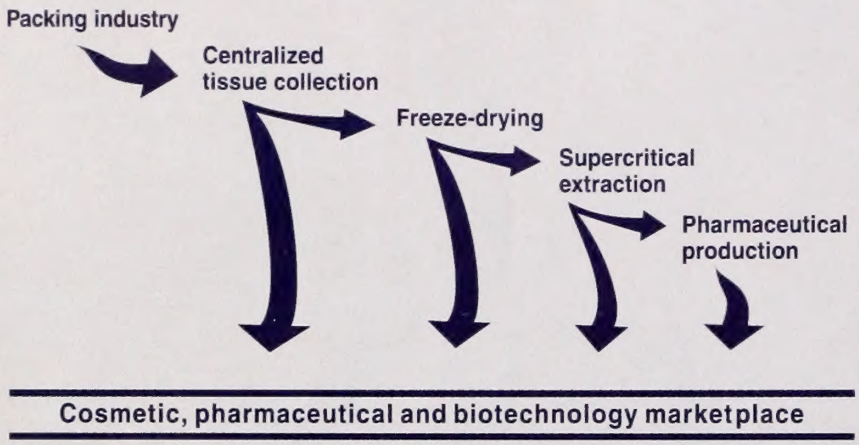
A time-worn adage claims 'one cannot make a silk purse from a sow's ear.' The implication that fine things in life do not arise from poor raw materials may generally hold true. However, a local agri-food company is working hard to dispel this philosophy as pure cliché. Norac Technologies Inc., an Edmonton based firm established in 1985, wants to turn low value by-products from Alberta slaughterhouses into high value commodities for the drug, cosmetic and biochemical industries. According to Dr. Tony Evans, Vice-President of Product Development and Marketing, this 'Midas touch' will be delivered with a leading-edge technology known as supercritical fluid extraction. Supercritical refers to the point at which a gas under pressure becomes so dense it behaves like a liquid, even though it is still a gas. To illustrate, the process can be likened to removing valuable components with water rather than air.

Norac's technology sprang out of Alberta's oil and gas patch. "Experimentation with the technology in upgrading petroleum products from coal and coke was not terribly successful," says Dr. Evans. "Its commercial potential was thought to be more promising in the biological field." Transfer of the technology from the petroleum to agri-food industry led to establishment of the Norac Extraction and Product Development Centre. Their extraction centre is the largest supercritical extraction pilot plant facility in North America.

Every gas has its own specific pressure at which it becomes supercritical. Norac uses simple, purified carbon dioxide gas. "In a compressed state, carbon dioxide

Inside

Figure 1
Development of an Alberta biologicals industry



is very efficient in removing the fat portion from plant and animal raw materials," says Dr. Evans. "It was our choice of gas since it becomes supercritical at relatively low pressure and, more importantly, at temperatures not far above room temperature. This is crucial since most of the valuable compounds are easily damaged by heat."

In this age of strict product safety requirements, supercritical extraction fits the bill by eliminating potentially harmful solvents," stresses Dr. Evans. "Traditional extraction of compounds for the food, drug and cosmetic industries has relied on solvents such as acetone and hexane. This is not ideal since they may change the valuable components. There is also the possibility of trace amounts of the solvents remaining in the finished product." He believes that using a harmless gas provides his firm with a competitive advantage.

Norac began its supercritical fluid extraction work with plant materials. The technology was initially used for production of flavours and food additives from herbs and spices. Norac holds patents for the process in Canada, the United States, Japan, India and the E.E.C.

"Due to low heat exposure, supercritical extraction produces higher quality flavours than conventional steam distillation," says Dr. Refe Gaudiel, Head of the Special Crops Section at Alberta Agriculture's Special Crops and Horticultural Research Centre in Brooks. "There certainly is a potential for this technology to raise the value of some of Alberta's special crops such as coriander, caraway, sage, basil and monarda."

"The beauty of this technology," explains Dr. Evans, "is that it is not only safe and efficient, but we can also use it to break down extracts into individual compounds, simply by adjusting temperature and pressure. One can, for example, separate pepper extract into a hot, pungent fraction and a sweet, aromatic component with a simple pressure adjustment."

The ability of the technology to separate crude mixtures into individual components led to Norac's discovery and patenting of a powerful food and cosmetic additive derived from herbs such as rosemary, sage, thyme and oregano. As a result of Norac's success with herbs and spices, Dr. Evans anticipates his firm will soon announce their intention to launch an $8 million Edmonton facility for commercial production of high value plant by-products.

Adding value to Alberta's crops with its patented technology is only part one of Norac's plan to diversify and add value to the province's agri-food industry. With its pioneering spirit of innovation and entrepreneurship, the next logical step for the company was to research the application of this technology to the meat industry.

With financial assistance from the **Alberta Agricultural Research Institute's Farming for the Future Program**, Norac plans to 'pan for gold' in the large offal stream from Alberta's abattoirs. Traditionally considered as waste material, offal - which literally means 'off fall', the portion of the carcass which falls off during dressing - consists of parts such as the brain, heart, kidney, liver, lung, pancreas, spleen, stomach, thymus and tongue.

Alberta is the largest producer of livestock in Canada. Meat processing constitutes the largest portion of the province's food processing industry. With over one million cattle, nearly two million hogs and just under

100,000 each of sheep and horses slaughtered annually, large quantities of offal are available for value addition.

Although many people may think of offal as garbage, Dr. Bill Ballantyne, Vice-President of Gainers Inc., advises, "Most offal is eaten, either as human 'variety meats' or as pet food. Most of the variety meats produced in Alberta are exported. It's mainly cultural preference - the Japanese, for example, eat hog lungs and we do not. Even the inedible portion that is melted down is not wasted. It is converted into edible fats, animal feed, ingredients for cosmetics and many other useful products."

Many offal tissues contain substances of great value to the drug and cosmetic industries. Biologically active enzymes, for example, are compounds required by and normally present in the human body. Part of the population, however, may be deficient in a particular enzyme. Cystic fibrosis patients are deficient in enzymes normally produced by a healthy pancreas. With Norac's technology, the enzymes can be extracted from a pig's pancreas, also a source of insulin required by diabetics.

"Prices for some of the drug compounds are astounding," says Dr. Evans. "They can range from hundreds of dollars a gram to $60,000 a gram for chemicals used in cancer research and highly concentrated in the animal's brain. From a cheap by-product, we may potentially extract chemicals worth $60 million per kilogram!"

Supercritical extraction of valuable products from animal tissues offers the same advantages as plant materials. It can also be much more cost-effective. "When we extract plant products, the valuable component is the oil portion, which usually amounts to only 10 per cent of the raw material," explains Dr. Evans. The remaining 90 per cent residue can be used as livestock feed. "The complete reverse is true with animal tissues, from which we want the non-fat residue. We can recover 75 per cent of this residue with our process."

Figure 1 shows Norac's concept of an Alberta biologicals industry supplied by raw materials from local slaughterhouses. The first research stage of producing offal extracts has been successfully completed. The next stage, according to Dr. Evans, is to develop a cost-effective system for collecting and preserving tissues from the meat packing industry.

"It has been a co-operative effort from the start, and we will have to continue in that spirit," he says. "From the start, we have received tremendous support from the Alberta Agricultural Research Institute, the research community and the industry. We must now go to Alberta meat processing plants, medical people and other experts to help bring the whole concept into commercial reality."

"When the company just started, its founders dreamt of a world leading technology that would help diversify and strengthen Alberta's agri-food industry. One of our ultimate goals was also to diversify the province's overall economy by attracting the drug and cosmetic industry to Alberta," says Dr. Evans.

If Norac can combine a cost-effective production system with its high technology, we may someday see those Alberta-made 'silk purses' rolling off the production line.

Dateline

July-August
On-farm demonstration tours in all six agricultural regions. Contact your local D.A. for dates and locations.

August 9
Meeting of AARI Board of Directors, Edmonton.

August 10
AARI and CARC (Canadian Agricultural Research Council) joint tours of the University of Alberta, the Norac Extraction Centre (Edmonton) and a local farm. BBQ at farm of Mr. Ralph Jesperson, AARI Board director.

November 1
Deadline for research applications under the following AARI programs:
1. Farming for the Future Research.
2. Matching Grants.
3. Research Co-ordination.

November
Forage and pulse review, Agricultural Research Reviews Program.

Breeding soft wheat hard work

AARI funded research worth $29 million according to consultants

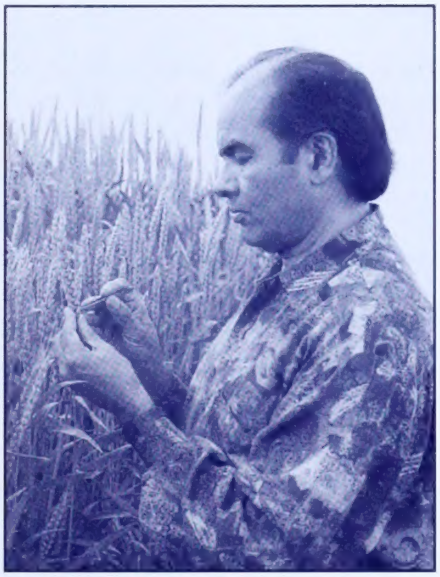
Breeding the perfect soft wheat is like trying to solve a Chinese puzzle - there is always a piece or two that will not fit. Maintaining a successful crop breeding program is a long-term challenge at best, like a marathon race with no finish line in sight. Just ask Dr. R.S. Sadasivaiah, Research Scientist in charge of the soft white spring wheat (SWSW) breeding program at Agriculture Canada's Research Station in Lethbridge.

"Adapting soft wheat to Alberta conditions is a never-ending research and development process," says Dr. Sadasivaiah. "One may make several improvements at once but obtaining the ideal combination of yield, disease resistance, and milling and baking qualities is difficult, if not impossible, to achieve. There are so many diseases that can attack soft wheat. Most are caused by moulds which can change form, or mutate, quickly. Staying ahead of them is a real challenge."

With a wealth of crop breeding experience, including canola, barley and oats, Dr. Sadasivaiah inherited the SWSW breeding program at the Lethbridge station in the mid-1980s. The program began in 1980 under the supervision of Dr. J. Thomas and Dr. M. Grant. From its start, the program has received funding from the **Alberta Agricultural Research Institute (AARI)** under its **Farming for the Future Research Program, Farming for the Future On-Farm Demonstration Program** and **Matching Grants Program.**

Soft white spring wheat is a specialty crop in Canada, according to Brian Stacey, Information Co-ordinator for the Canadian Wheat Board. "Because of its specialty crop status, it has been grown under a guaranteed delivery contract with the Wheat Board," says Mr. Stacey. "It is a low volume crop, so there is no problem selling all that is currently produced."

In comparison to Canada's premium hard red spring wheat and other classes of wheats, SWSW has multiple end-uses. Its low protein and high starch



Dr. Sadasivaiah crosses soft white spring wheat varieties

content does not make it suitable for yeast-leavened bread but it is preferred in products requiring low protein. Soft white spring wheat thus diversifies Alberta's agri-food industry since its flour is used in a wide array of processed foods. In addition, SWSW offers producers the advantage of a higher yield potential than most other classes of wheat grown in western Canada.

Alberta produces approximately 90 per cent of western Canada's SWSW, all of which is grown under irrigation in the southern part of the province. Currently, 80 per cent of our soft wheat is sold in export markets. Dr. Sadasivaiah explains, "Soft white spring wheat is currently grown under irrigated conditions because it is higher yielding than under dryland conditions. By irrigating, we also obtain the lower protein content required for pastries, cookies and cakes. This, however, does not rule out the possibility of dryland production in the future." As Mr. Stacey indicated, there is increasing international demand for SWSW with higher protein content, for use in Middle East flatbread, as an example. These markets could be an outlet for SWSW grown under dryland conditions.

What SWSW flour lacks in bread-making quality is made up for in versatility. It produces a weaker dough used in cookies, pastries, cakes, noodles, biscuits and flatbreads. To satisfy these diverse markets, however, suitable wheat varieties that thrive in Alberta must be developed. Enter Dr. Sadasivaiah's breeding program.

Soft white spring wheat acreage in Alberta peaked at 450,000 in 1984. By 1991, it had declined to 220,000 acres. According to Andy Kovacs, Executive Director of the Alberta Soft Wheat Producers Commission, "The acreage decreased because there are only 1.3 million acres of land under irrigation in Alberta and that land is required for other crops. The

soft wheat acreage has recovered somewhat in the last few years, however, largely because of GRIP (Gross Revenue Insurance Program)."

Dr. Sadasivaiah maintains that, apart from low world grain prices, the major factor limiting soft wheat production in southern Alberta has been the lack of suitable cultivars. "Despite the economic importance of soft wheat to Alberta, only American varieties were available prior to initiation of the breeding program at Lethbridge," he says. "This was unsuitable since they were not bred for Alberta soil and environmental conditions. The American breeders also made no attempt to produce soft white spring wheat with kernels easily distinguished from other classes of Canadian wheats."

Early varieties of SWSW grown in Alberta were obtained from the United States Department of Agriculture (USDA) breeding program at Aberdeen, Idaho. Although these varieties have some desirable qualities for Alberta production, they are not sufficiently disease resistant and/or compatible with the Canadian grain handling system. Owens, for example, despite its resistance to the major disease stripe rust, was de-registered in 1991 because it could not be easily distinguished from the white Canada Prairie Spring class of wheat.

Many years of hard work by the Lethbridge team were recently rewarded. Two new varieties of SWSW were developed for western Canadian conditions. The first variety, SWS-52, has good overall disease resistance and higher flour yield. However, it matures later than the current standard, Fielder. It also has stronger gluten (wheat protein), which is not preferred in the domestic baking industry. As a result, it was only granted an interim, five-year registration.

The second variety, AC Reed, is the breeding program's crowning achievement to date. Since the program began, it is the first variety to receive permanent registration. Commercial seed will be available in 1994. AC Reed is superior in many ways to Fielder. In multiple site field trials, it showed a six to 10 per cent higher yield than Fielder and good resistance to current types of stripe rust. It also fared as well or better than Fielder in milling and baking tests. "The development of AC Reed was a major achievement in research and should be of tremendous benefit to producers of soft wheat in Alberta," says Mr. Kovacs.

The development of AC Reed was the culmination of over ten years work spanning three research projects funded by the Farming for the Future Program. Conventional plant breeding methods were used. "The Chinese puzzle analogy is accurate in that hundreds of combinations must be tried to arrive at the solution," says Dr. Sadasivaiah. "One must cross many, many varieties to come up with a soft wheat that will satisfy the farmer, miller and baker. For the development of AC Reed and SWS-52, over 1,200 promising lines of soft wheat developed at the Lethbridge Research Station were evaluated. Some of the parent wheats originated from the United States, Mexico, Australia, India, Ecuador and Kenya."

Dr. Sadasivaiah continues, "Although plant breeding with the use of biotechnology requires years of work prior to commercial reality, our conventional methods take even longer. We were fortunate in our research to receive the co-operation from the USDA winter nursery at Brawley, California. This cut the breeding time considerably, allowing us two crops per year. After we made selections in southern Alberta, the new material was transferred to California in late fall for a winter increase."

As Mr. Kovacs mentioned, results from the Lethbridge program should greatly benefit producers. A specific dollar value has been determined recently by an Edmonton consulting firm. Serecon Management Consulting Inc., in their study of Farming for the Future benefits, chose two of Dr. Sadasivaiah's SWSW breeding projects for evaluation. The projects received total funding of $605,600 from Farming for the Future. According to the consultants, this was an extremely wise research investment. They estimated the present value of economic benefits over a 10-year period to be a staggering $29 million. This was based on yield increase alone and did not take into account improvements in quality.

One might think this is the end of an agricultural success story. However, almost as quickly as AC Reed 'hit the ground,' Dr. Sadasivaiah's team went to work to replace it with an improved variety. This latest research project is funded jointly by AARI, under its Matching Grants Program, and by the Alberta Soft Wheat Producers Commission. "We are very pleased with our progress to date," says Dr. Sadasivaiah, "however, we can still make further improvements. We would like to replace AC Reed with a variety that is higher yielding, lower in protein and more resistant to black point disease." A plant breeder's work is never done! ⩔

Spotlight on Farming for the Future

As Chairman of the Alberta Agricultural Research Institute's Board of Directors, I am very pleased to highlight a tremendous program of the Institute - Farming for the Future. I am also pleased to introduce the first issue of a new look *Research Report*. We hope longstanding and first-time readers will enjoy its continued coverage of important agricultural research and technology transfer in Alberta.

Farming for the Future is an outstanding Alberta success story. Having served as an original member of the former Farming for the Future Council and as a research scientist at the Agriculture Canada Research Station in Beaverlodge, I feel that my position with the Institute is somewhat of a homecoming. I look forward to once again being a part of Farming for the Future's many achievements and the other excellent programs administered by the Alberta Agricultural Research Institute.

The Alberta Agricultural Research Institute welcomed the merger with the Farming for the Future Program in 1991. The benefits of this highly successful agricultural research and technology transfer program were studied that year by Dr. Travis Manning, Professor Emeritus of Agricultural Economics at the University of Alberta.

Dr. Manning conservatively estimated the economic benefit of the Farming for the Future investment to be $939 million over the next 25 years. He concluded that "very few alternative public investments could hope to earn nearly the high rate of return this program enjoys."

A more recent evaluation of Farming for the Future was conducted by Serecon Management Consulting Inc. of Edmonton. Serecon performed an in-depth assessment of ten research projects and ten on-farm demonstration projects. The evaluation was based on financial analysis of data, file reviews and interviews with researchers, extension personnel, farm co-operators and end-users. Serecon estimated a direct economic return to the provincial economy, over 10-15 years, of $456 million (1992 dollars) from these 20 projects alone!

Serecon's evaluation is indeed astonishing when one considers that actual expenditures for 1,500 research and demonstration projects, since Farming for the Future's inception in 1979, were only $63 million in comparison. To illustrate the consultants' findings, research projects investigating ruminant nutrition, at a cost of $1.1 million, were estimated to have a 1992 economic benefit value of $34 million. An on-farm demonstration project which studied agronomics of field pea varieties, at a cost of $29,000, was estimated to have a 1992 economic benefit value of $12.8 million.

Benefits arising from the Farming for the Future Program extend well beyond simple dollars and cents. Harder to measure, but equally important, are the benefits of job creation, training of new scientists and advancement of agricultural knowledge. The Farming for the Future Program has been, and will continue to be, an important investment for Albertans.

The spotlight truly has been on the Farming for the Future Program in the past year. In November, the Institute held the 1992 Farming for the Future Conference in Red Deer, Alberta. With its theme of "Agri-Food Diversification," the conference attracted over 200 producers, processors, researchers, extension personnel and members of the media.

During the conference, leading-edge research results were conveyed to participants through a variety of interesting presentations and displays. The one-day gathering was capped off with a most interesting speech by former Associate Minister of Agriculture, the Honourable Shirley McClellan, in which she emphasized the need to intensify agricultural research efforts in Alberta.

On behalf of the Institute, I would like to thank the Honourable Shirley McClellan, recently retired Deputy Minister of Agriculture and past Board Vice-Chairman, Mr. Ben McEwen, outgoing Chairman, Mr. Bob Bogle, and former Board Director, the Honourable Jack Ady, for their valuable contributions to the Farming for the Future Program. The Alberta Agricultural Research Institute will certainly benefit in the years to come from their leadership legacy. ⩔

Dr. Bob Elliott, MLA
Chairman, Board of Directors
Alberta Agricultural
Research Institute

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